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I-deas TMG to NX Space Systems Thermal Model Conversion and Computational Performance Comparison

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Agenda

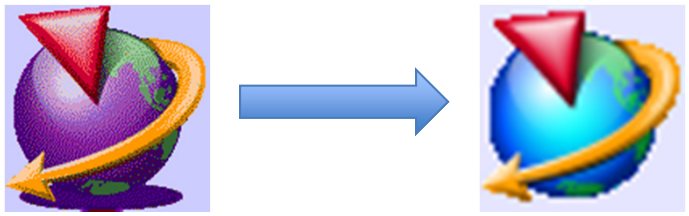
- Introduction
- Solution Approach
- Hardware Setup
- Models
- Computational Time
- Computational Precision
- Conclusions

Introduction

- CAD/CAE packages change on a continuous basis as the power of the tools increase to meet demands
- End-users must adapt to new products as they come to market and replace legacy packages
- CAE modeling has continued to evolve and is constantly becoming more detailed and complex
  - Comes at the cost of increased computing requirements
- Parallel processing coupled with appropriate hardware can minimize computation time

Introduction

- Users of Maya Thermal Model Generator (TMG) are faced with transitioning from NX I-deas to NX Space Systems Thermal (SST)
- Important to understand what differences there are when changing software packages
  - Consistency in results



I-deas TMG NX 7.5 SST

Solution Approach

- Used an existing I-deas TMG, steady state thermal math model (TMM) of hardware that has been tested and has been correlated to empirical values
- Ran TMM using various hardware configurations to observe computational time
- Checked precision of output for each hardware configuration to see if errors were generated in the parallelization process

Solution Approach

- Converted I-deas TMG model to NX 7.5 SST and repeated runs to compare performance (computational time and precision)
- Performed secondary study with a large, transient TMM for select cases to check consistency of study results in a transient situation

Hardware Setup

- Two Dell Precision 690 Workstations
  - Dual Intel Xeon 5150 processors (2.66GHz dual core w/4MB L2 cache, 1333MHz system bus)
  - 4GB DDR2 667MHz ECC SDRAM (4 FB-DIMMs)
  - NVIDIA Quadro FX 3500 (256MB dedicated)
  - 750 GB Hard drive (7200rpm)
- Three Dell Precision 390 Workstations
  - Intel Core2 Extreme QX6700 processor (2.66GHz dual core w/8MB L2 cache, 1066MHz system bus)
  - 4GB DDR2 667MHz ECC SDRAM (2 DIMMs)
  - NVIDIA Quadro FX 3500 (256MB dedicated)
  - 750 GB Hard drive (7200rpm)

IOM: Testing Parallelized TMG for Use in Production Environment, 3540/SECTION/011-2007, October 5, 2007

Hardware Setup

	2 Dell Precision 690s		3 Dell Precision 390s		
					
CPU cores*	2 x 2 x 2	+	3 x 1 x 4	=	20
Video cards**	2 x 1	+	3 x 1	=	5

* # cores = (# PCs)(# CPUs/PC)(# cores/CPU) = #CPUs

** # cards = (# PCs)(# cards/PC) = #GPUs

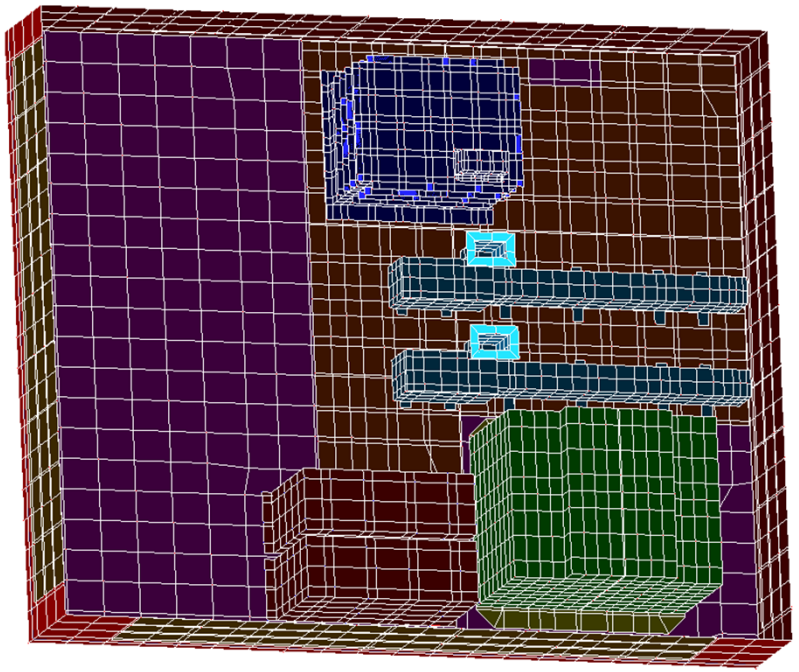
IOM: Testing Parallelized TMG for Use in Production Environment, 3540/SECTION/011-2007, October 5, 2007

Hardware Setup

- Parallelization involves using MPICH
  - Must be installed on each computer
  - User must register MPICH credentials in each computer
  - Each computer must have the same TMG patch
  - TMG directory location must be identical for each computer

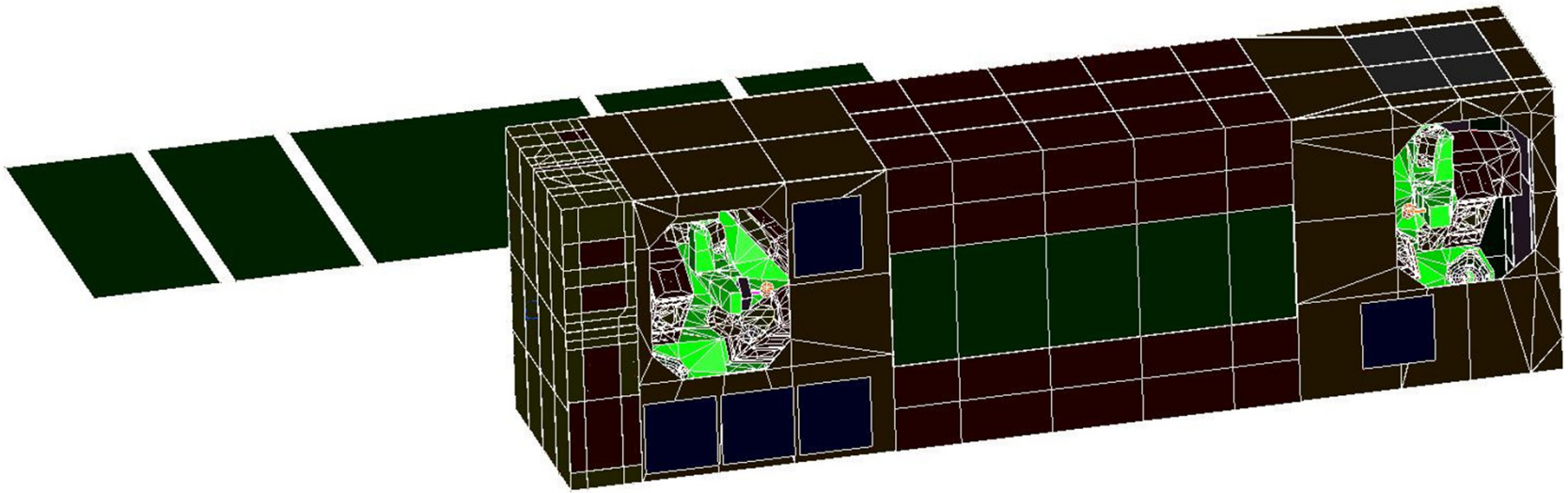
Models

- Steady state TMM obtained from Juno flight project (5,768 nodes / 5,222 elements)



Models

- Transient TMM obtained from SIM flight project (33,398 nodes / 30,498 elements)

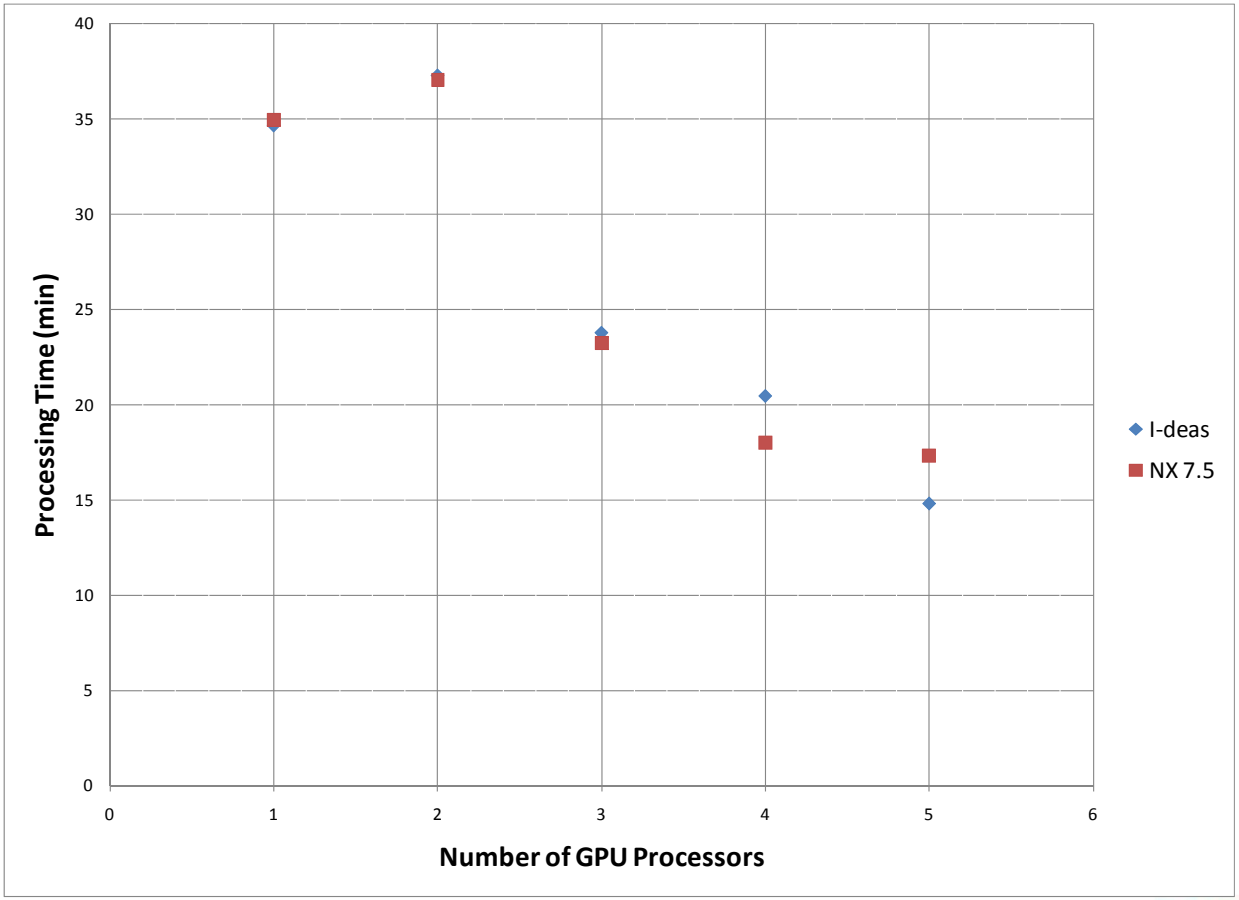


Computational Time

- Only the view factor calculations are parallelized
- View factors can be calculated using two different methods and processors
  - HEMIVIEW: uses graphics cards (GPUs) for calculations
  - VUFAC: uses CPU cores for calculations

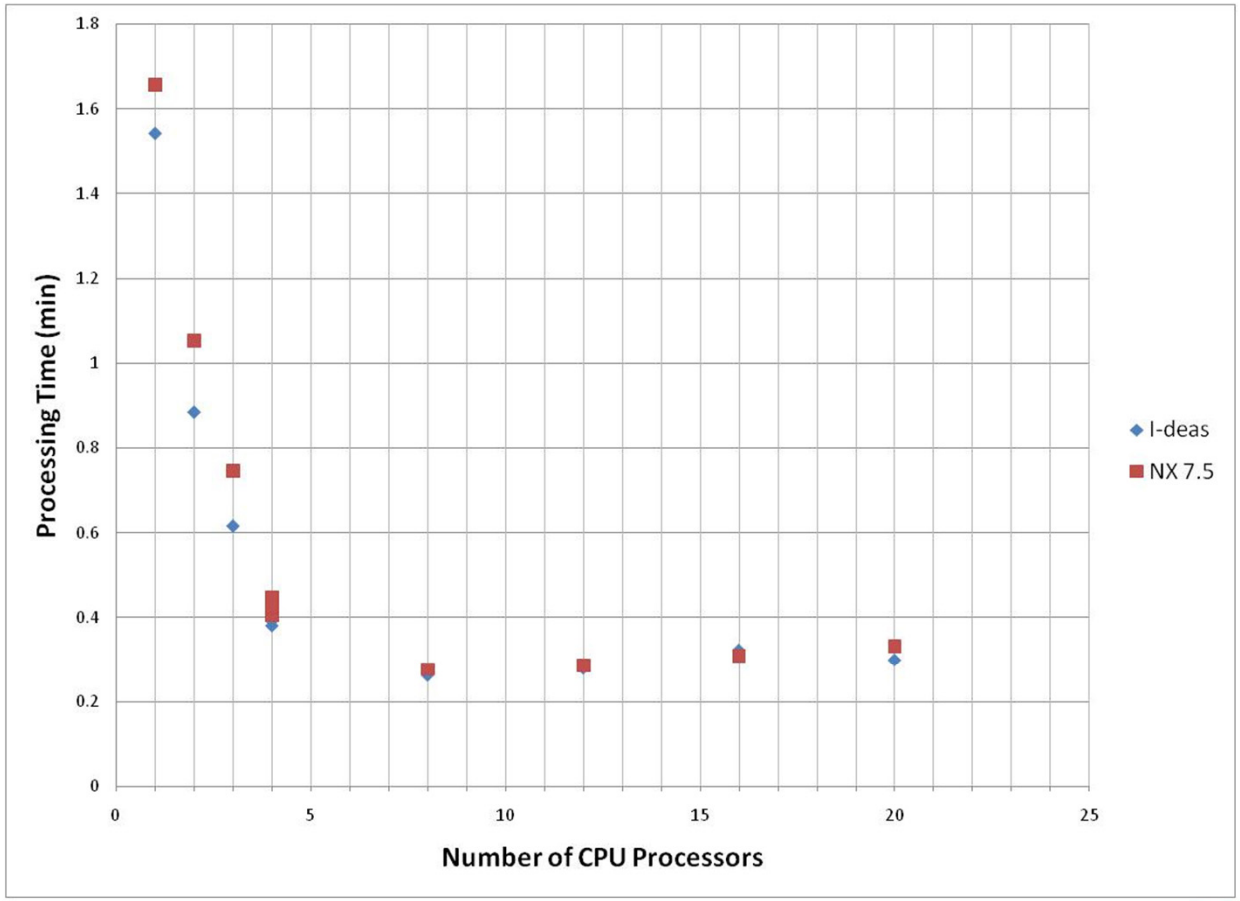
Computational Time

- HEMIVIEW, Steady State Juno model



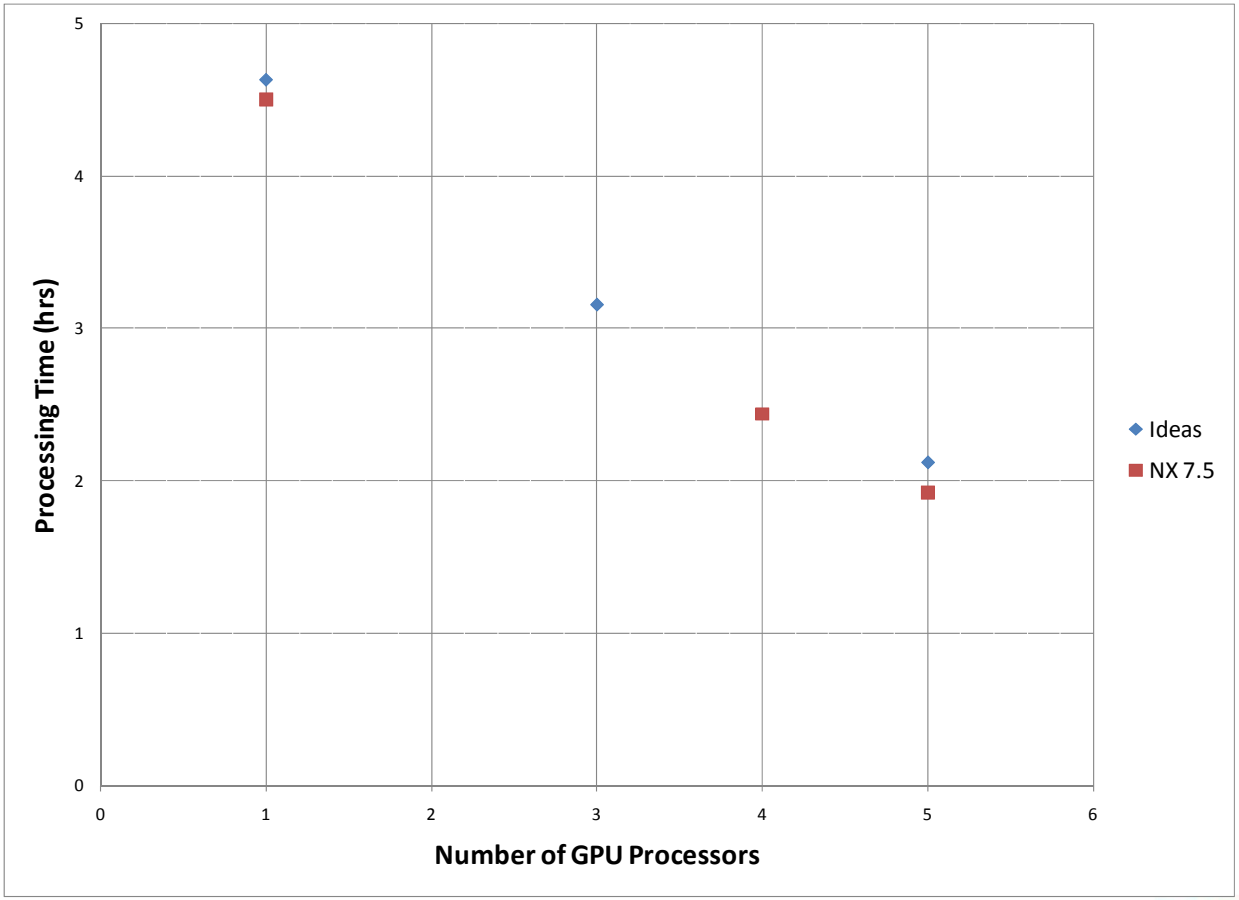
Computational Time

- VUFAC, Steady State Juno model



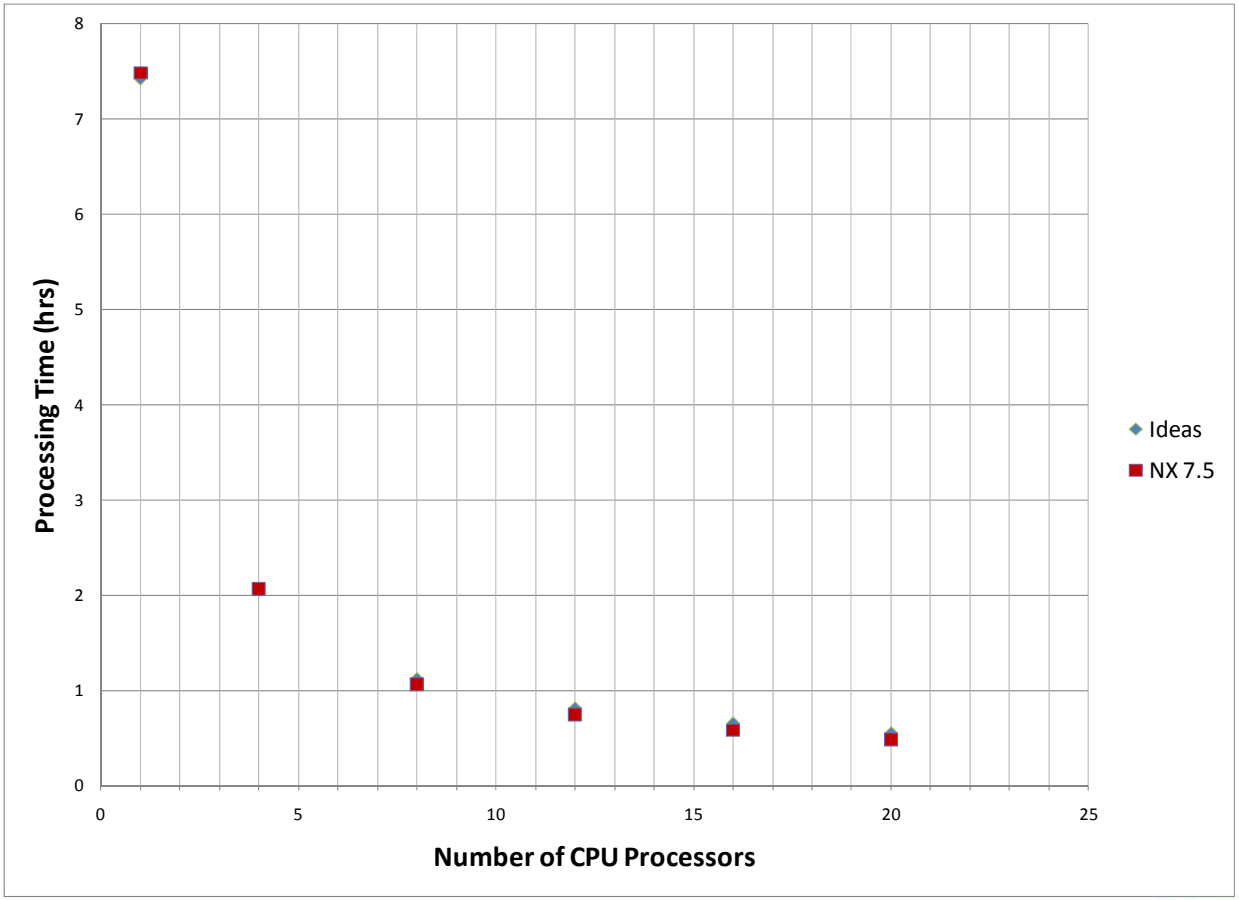
Computational Time

- HEMIVIEW, Transient SIM model



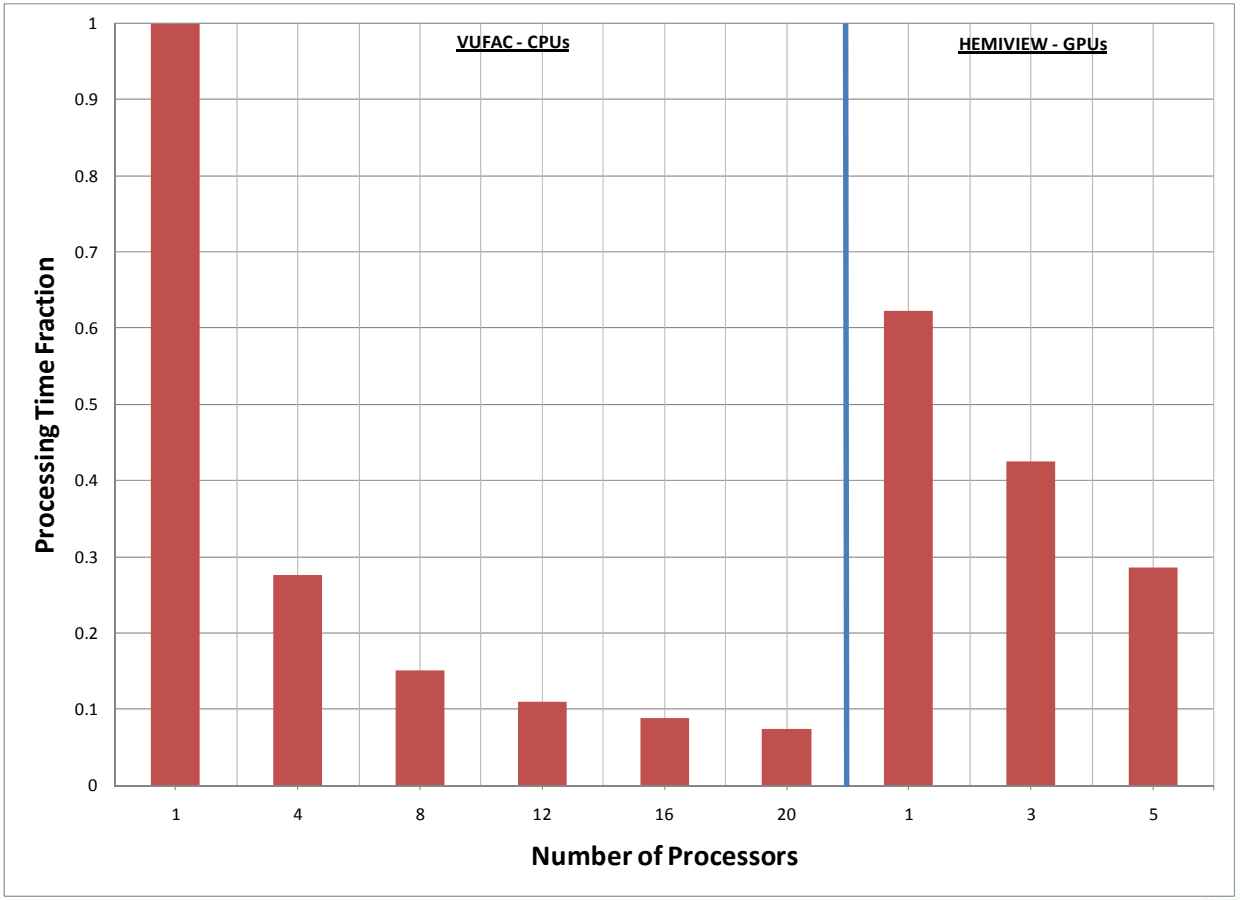
Computational Time

- VUFAC, Transient SIM model



Computational Time

- Transient SIM model



Computational Precision

- Use of parallel processing did not result in any change in calculated temperatures
- Other setup differences resulted in the following maximum temperature differences
  - Note that it is not clear whether differences in the Ideas TMG and NX 7.5 SST are due to patches, model conversion, or changes in the software packages

Calculation Differences	Max ΔT (°C)
Patch 6.0.852 vs 6.0.958	$8x10^{-5}$
VUFAC vs HEMIVIEW	0.06
Ideas TMG vs NX 7.5 SST	0.6

Results Summary and Conclusions

- Parallel processing has shown to reduce view factor calculations by as much as 10X for large models
  - Small models show that parallel processing can actually slow calculation time, most likely due to the overhead calculation configuration required when parallel processing
- Available hardware may determine whether VUFAC or HEMIVIEW should be used as far as calculation speed is concerned
  - In general, VUFAC shows larger decreases in calculation time when done in parallel

Results Summary and Conclusions

- Overall, it has been shown that usage of the parallel processing capabilities within Ideas TMG / NX 7.5 SST has consistent results regardless of the number of processors used
  - Caution should be used when comparing analysis between different patches and/or when converting between Ideas and NX
- Maya is in development of a parallelized ANALYZE module for temperature calculation which would significantly help decrease overall model calculation time

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